20 years of SPM at ASU (1986-2006)

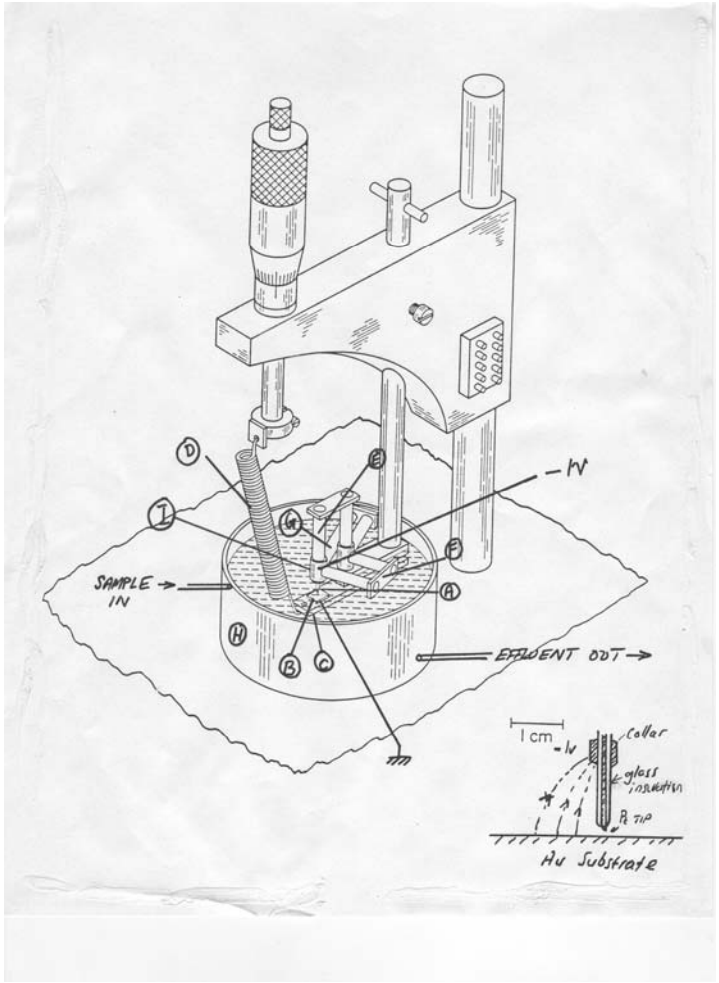
STM Invented 1981 *(Binnig et al., Phys Rev, Lett.* ***49****, 57 , 1982)*

STM in 1985 – Groups with Instruments

IBM (Zurich, TJ Watson, Almeden)
ETH Zurich
Stanford
UCSB
UA Madrid
Nijmegen, Netherlands
Ford Motor Co., DearbornTohoku U., Japan
Tskuba, Japan
Bochum, Germany
Munchen, Germany

(inferred from the proceedings of the first international conference on STM, 1986)

STM in water: the “dipping duck”

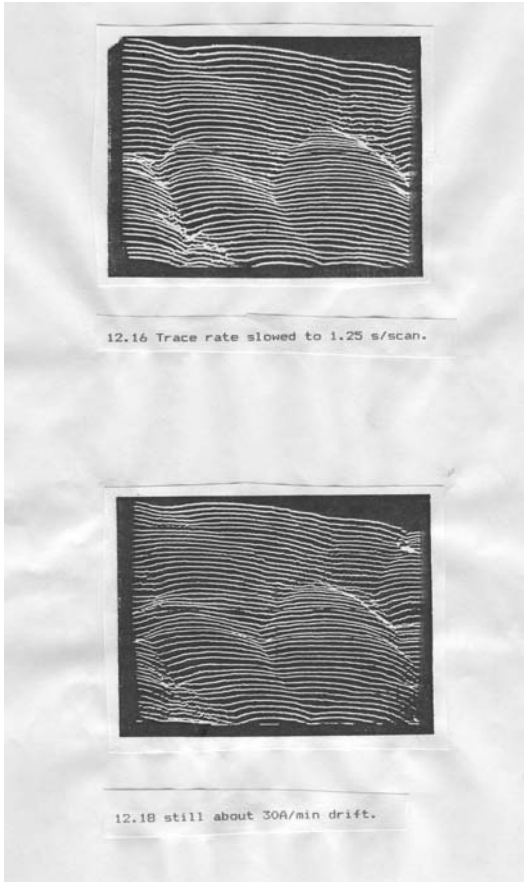


- Paul Hansma’s instrument at UCSB (Science **232** 211 1986)
- Sketch at lower right shows modification for applying an electric field with which to deposit DNA electrochemically.
- First trials late 1985 –written up in a January 1986 (unpublished) report

Experiments with DNA at UCSB

(from Jan 29,1986 report)

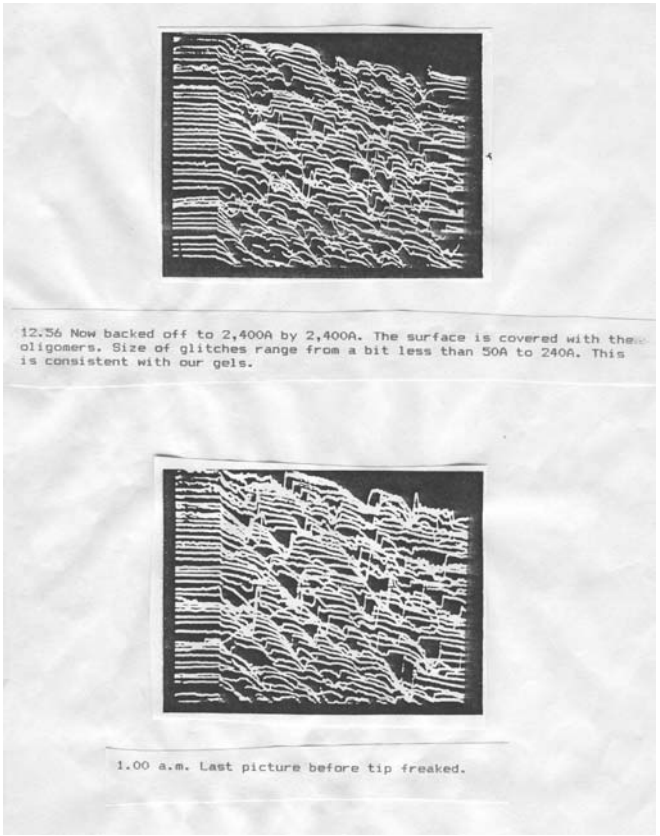
- Nothing stuck to graphite
- Tried gold on glass



About 500Å square. The 'hills are individual gold crystallites prepared by evaporation onto glass.

Experiments with DNA at UCSB

- 60bp double helical DNA prepared by sonication and filtration

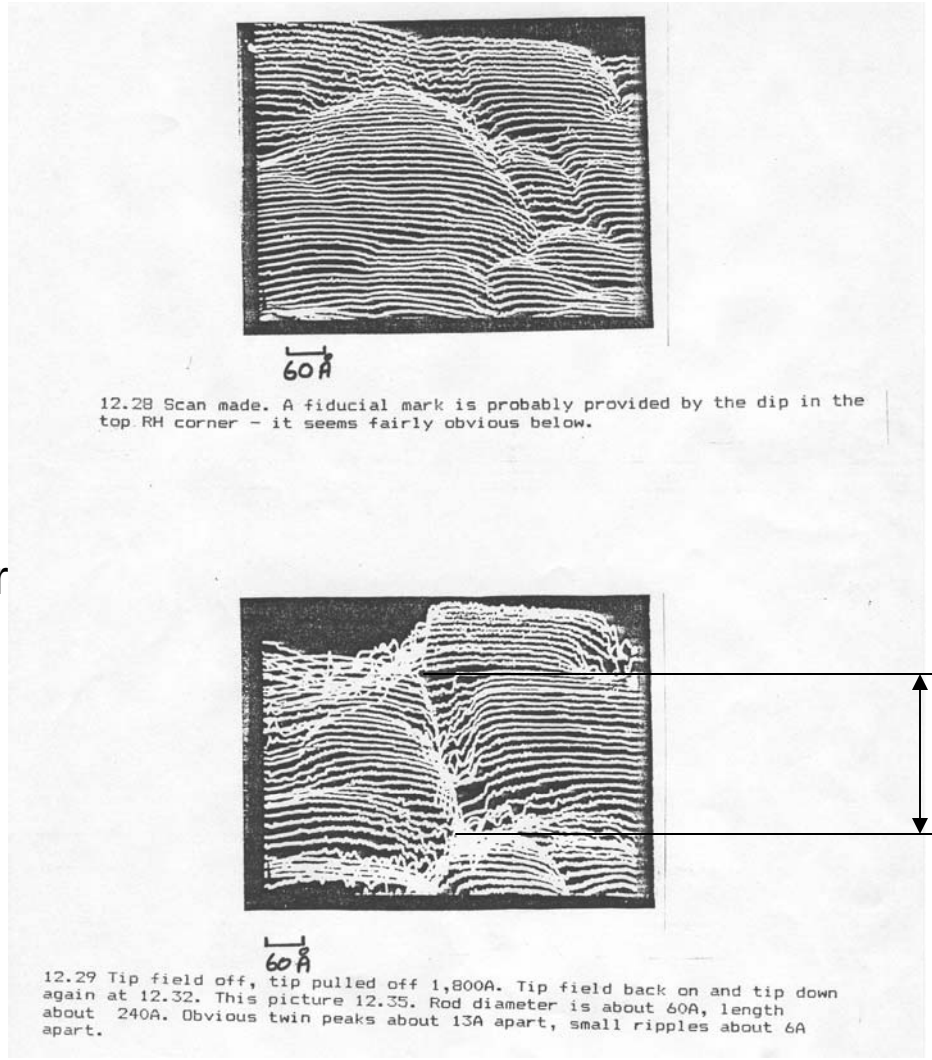


The previously ‘smooth’ gold crystallites became bumpy like this when DNA was deposited. The DNA appeared as ‘dips’ in the surface.

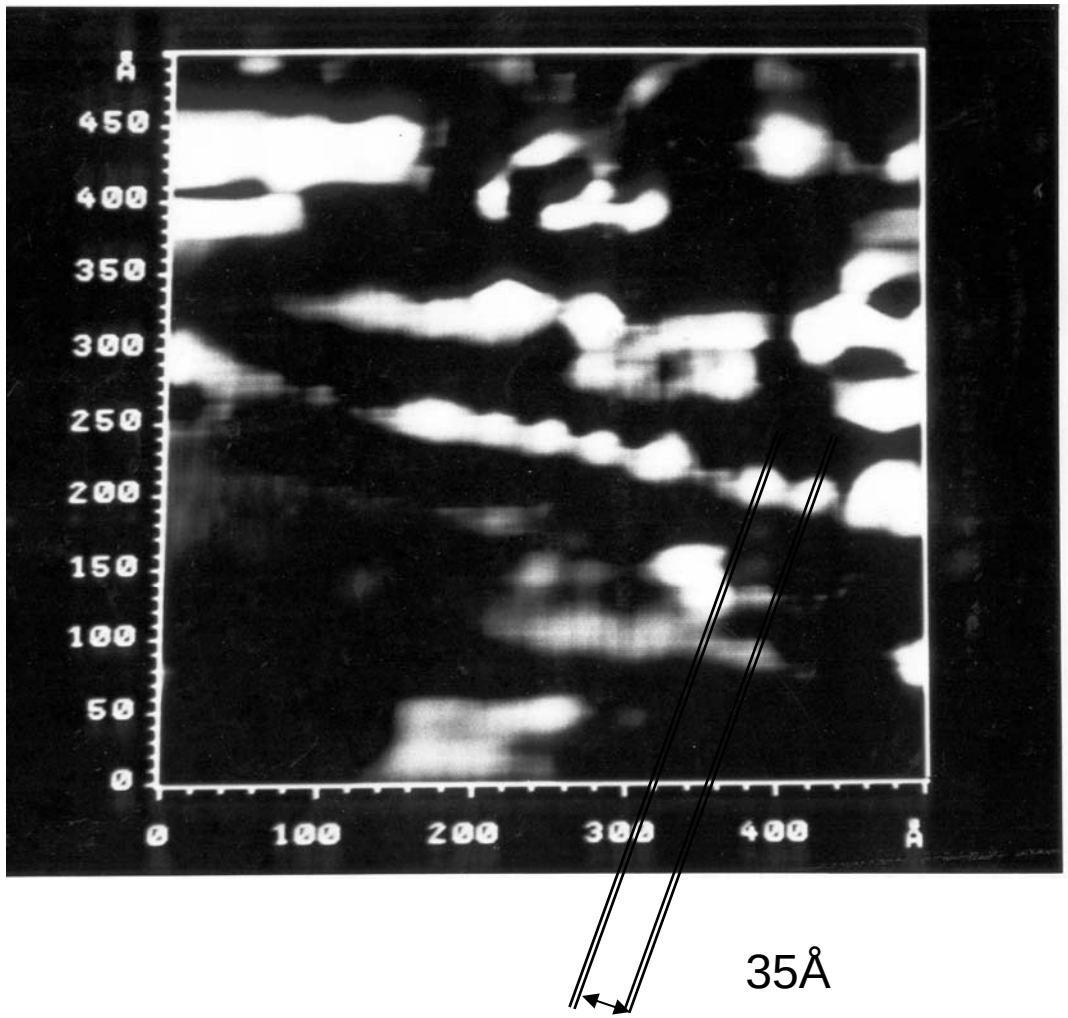
Experiments with DNA at UCSB: before and after images

In this experiment, the same area was imaged before and after DNA deposition (note dip in upper right hand corner).

The work was never published because we did not understand the negative contrast and the electrochemistry was erratic.



By 1987: computer control and digital image acquisition



These were the first results that were both reproducible and for which we had a model for image contrast (published in Proc. STM 1988)

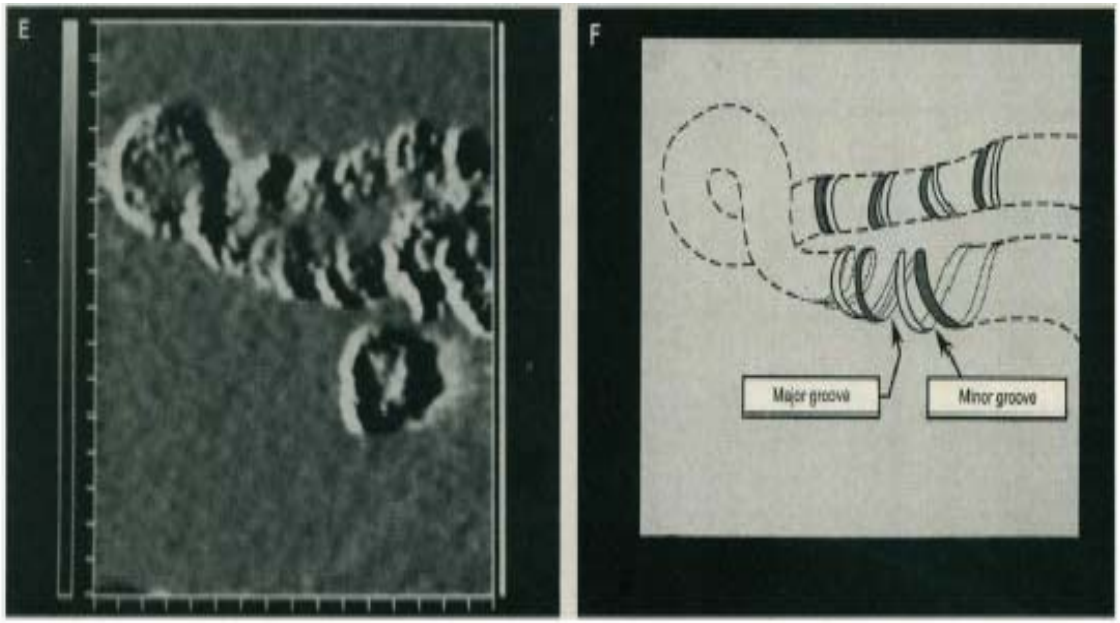
DNA on Au in solution

Direct Observation of Native DNA Structures with the Scanning Tunneling Microscope

THOMAS P. BEEBE, JR., TROY E. WILSON, D. FRANK OGLETREE, JOSEPH E. KATZ, ROD BALHORN, MIQUEL B. SALMERON, WIGBERT J. SIEKHAUS

Uncoated double-stranded DNA dissolved in a salt solution was deposited on graphite and imaged in air with the scanning tunneling microscope (STM). The resolution was such that the major and minor grooves could be distinguished. The pitch of the helix varied between 27 and 63 angstroms in the images obtained. Thus the STM can be useful for structural studies of a variety of uncoated and isolated biomolecules.

DNA (?) on graphite in air, Beebe et al., Science **243** 370 1989



Inspired by our presentation at STM 88, The Lawrence Livermore group took these images in November 1988 How come they could get things to stick to graphite?

DNA in water on Au

Lindsay et al., Science **244** 1063 (1989)

After Tom Thundat obtained nice images of isolated molecules electrochemically-deposited on gold, we sent this paper to Science.

Death of the field till the 2000's

Graphite: A Mimic for DNA and Other Biomolecules in Scanning Tunneling Microscope Studies

CAROL R. CLEMMER AND THOMAS P. BEEBE, JR.*

Highly ordered pyrolytic graphite (HOPG) is the substrate often used in scanning tunneling microscope (STM) studies of biomolecules such as DNA. All of the images presented in this article are of freshly cleaved HOPG surfaces upon which no deposition has occurred. These images illustrate features previously thought to be due to biological molecules, such as periodicity and meandering of "molecules" over steps. These features can no longer be used to distinguish real molecules from features of the native substrate. The feasibility of the continued use of HOPG as a substrate for biological STM studies is discussed.

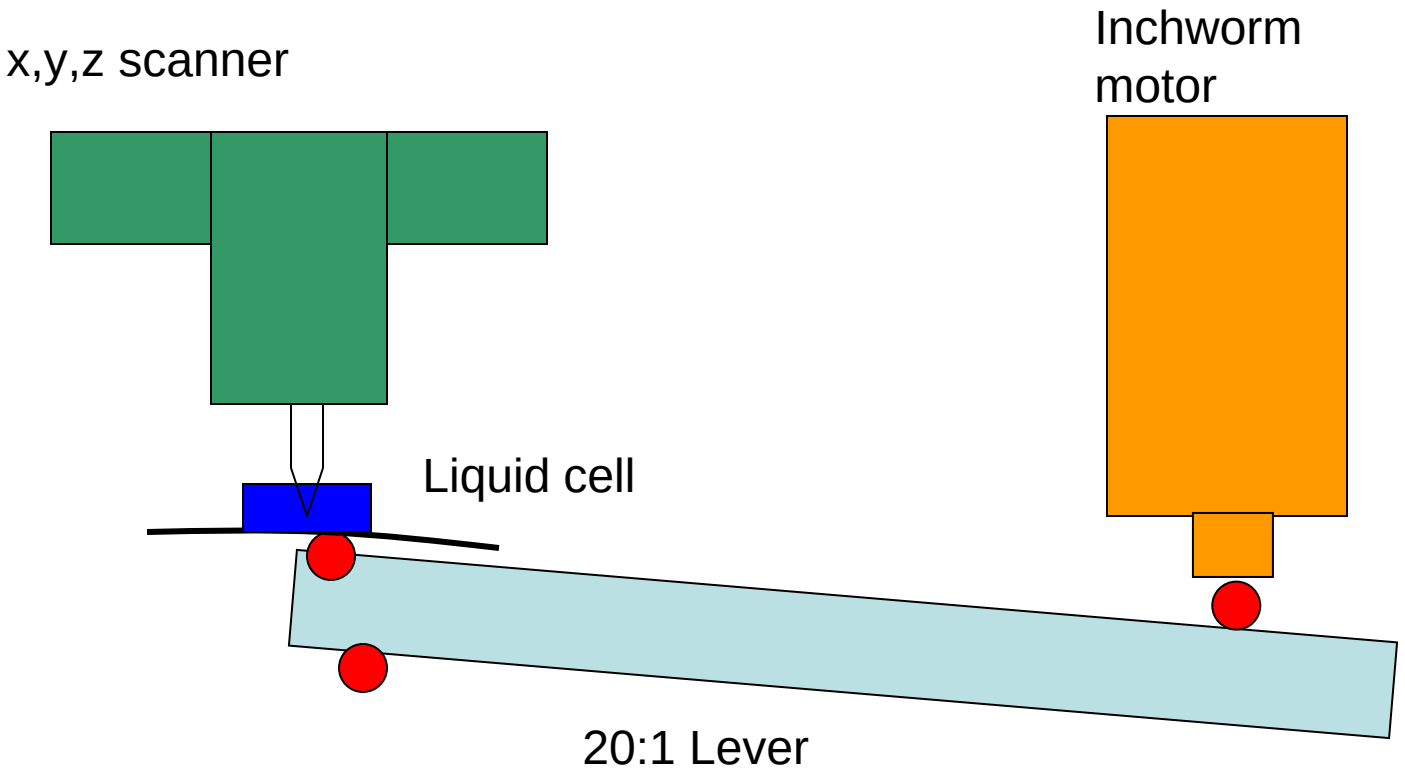
researchers need to be made aware of the surface features associated with HOPG (*14–16*).

We have completed an in-depth study of DNA molecules deposited electrophoretically onto HOPG and imaged in situ with the STM (*17*). The images we present in this article are taken from several hundred images of HOPG blanks that we completed concurrently with our in situ DNA studies. We present images illustrating regular periodicity from features that appear to meander across the surface. We examine HOPG steps and the confusion that they can bring to an image containing biological deposits.

A significant percentage of the previous work in this field has appeared in this and other highly visible, broadly viewed journals. It is not our intent to disprove or discount these previous results, but rather to enlighten the broader scientific community. A knowledge of the controversial interpretation of HOPG surface features will

But we were right about nothing sticking to graphite that first night in 1985!

The ASU STM, spring 1986



Built March/April 1986 with a small grant from Henry Reeves, ASU's first VP for research.